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TELEVISION MONITOR WITH ELECTRONIC ZOOM AND IMAGE POSITION CONT--ETC(U)
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TELEVISION MONITOR WITH ELECTRONIC ZOOM AND IMAGE POSITION CONTROL

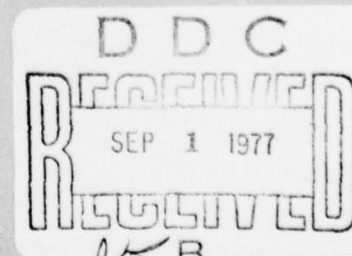
ADOLF R. MARKO
DAVID A. RATINO
AEROSPACE MEDICAL RESEARCH LABORATORY
DON McCOLLOR
RAYTHEON SERVICE COMPANY

JUNE 1977

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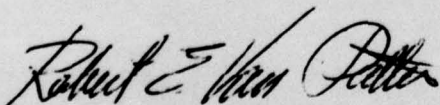
TECHNICAL REVIEW AND APPROVAL

AMRL TR 76-108

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER



ROBERT E. VAN PATTEN
ACTING CHIEF

Environmental Medicine Division
Aerospace Medical Research Laboratory

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) For simulators and other research applications a television display with variable image size and image position capability is often required. Television monitors featuring this capability, in addition to variable scan rate and high degree of linearity, have been developed by industry, but are too expensive for many applications. This report describes a relatively inexpensive modification of a commercially available television monitor for electronic remote control of scan size and image position. | | |

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PREFACE

This development work was accomplished at the Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio. Adolf R. Marko and David A. Ratino were the project officers for Aerospace Medical Research Laboratory. Don McCollor was the project engineer for the Raytheon Service Company, Burlington, Massachusetts. The authors express their gratitude to Ms. Peggy Lighthiser and Ms. Joanne Lawrence for their help in preparation of this report.

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INTRODUCTION

For some simulators used in the field of human performance measurements, a television display having the following modes of operation is desirable:

The image should be controllable in the X and Y position by voltages derived from a computer (or other devices).

The size of the image should be controlled by a variable DC voltage.

The obvious solution to this problem is to use a television camera with a servo-controlled zoom lens and a servo-controlled pan and tilt unit. This approach is often used, but has two limitations. First, speed for changing position and image size is limited by the electro-mechanical servo systems and the response characteristic of the camera tube (vidicon). Second, the resolution varies with size of the image and may be insufficient below a certain image size. Another approach to the problem is a television monitor with variable scan size and scan-field position. Such monitors are commercially available, but the price is approximately 40 times higher than the price of a standard TV monitor. These monitors are not mass production items and usually have much higher performance specifications, i.e., resolution, linearity, and stability.

For many applications, however, a TV monitor with the performance of a standard monitor would be adequate if it could be converted to the zoom and positioning capabilities at a reasonable cost. This report describes development work leading to the conversion of a commercially available TV monitor into a monitor with zoom and X-Y image positioning capability. This report may be useful for a person with experience and knowledge in television receiver and monitor technology, but is not considered adequate to teach the procedure to persons without previous experience in the television field. No complete literature search on the subject has been performed, and the patents have not been investigated at all. Therefore, the authors do not claim originality for this work and can not assume any responsibility for possible patent infringement.

PROBLEM ANALYSIS

Many television monitors and also complete television receivers have adjustments for the picture width and height, some have a switch allowing full screen area picture or reduced scan size. It may appear that variable scan size could easily be accomplished by expanding the range of the already available controls. For varying scan size of only 3% (from 7 in. full screen image width to 5 in.) the problem can be solved in this simple way. For this monitor, a minimum of 10:1 scan size variation has been requested, excluding the application of the previously mentioned approach.

There are two basic approaches for the magnetic deflection of a cathode ray beam in use. The commonly used technique, applied in almost every television receiver and monitor, works with resonant deflection circuits. This circuitry has been developed to maximum efficiency at a minimum cost for components. With a certain set of components it works only within a small range of scanning frequencies (scanning rates). The other approach, used in some special multi-rate precision television monitors, employs nonresonant linear deflection amplifiers. The amplifier for the horizontal deflection is rather expensive, because it must deliver peak power in the range of 300-500 volt-amperes, in addition to the required linearity and frequency response. The development of such amplifiers is not considered practical for an electronic support laboratory. Since the performance achievable with this special amplifier was not necessary for the particular application, the following description is concerned with this technique only for the vertical deflection.

TECHNICAL APPROACH

Figure 1 is a block diagram of the vertical deflection. The vertical ramp voltage from the original circuits in the monitor is used to feed the Y input of an integrated circuit multiplier. The X input for this multiplier is derived from the DC control voltage for the image height. The output of this multiplier is a vertical deflection ramp voltage controlled in amplitude by the size control voltage. A position control voltage and the output of the multiplier are summed in the following linear amplifier. The actual circuit (figure 3, page 6) used for the vertical deflection has, in addition to the components shown in the block diagram, an operational amplifier A1 to increase the ramp voltage to about 7 volts peak-to-peak and a second operational amplifier, A2, to perform mixing with the position control voltage and current linearization. A commercial power amplifier A3 (RCA-type HC-2000, up to 7 amperes) is used to drive the vertical deflection yoke. This amplifier was used because it was available from a previous project. Since the vertical deflection yoke requires only 0.3 amperes for full deflection, the HC-2000 could be replaced with a less expensive type, delivering only ± 0.5 amperes at ± 15 volts.

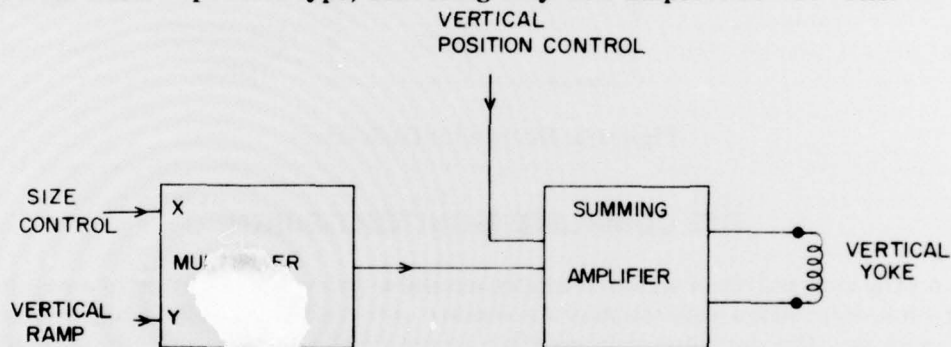


Figure 1. Vertical Deflection

The horizontal deflection circuit is similar in operation to the original circuits in the monitor, except for the size control and position control features. In the monitor, the horizontal deflection circuit is also used to generate the high voltage and the focusing voltage for the cathode ray tube, as well as the horizontal blanking pulses. For this reason, it is not practical to modify the circuit in the monitor for size control, because this would affect brightness, focusing, and blanking. A coil with approximately 167 microhenries has been substituted for the horizontal deflection yoke in the monitor to keep high voltage generation, focusing, and blanking in operation. The connections to the horizontal deflection yoke have been brought out of the monitor via an RG 59 coax cable and connected to an auxiliary deflection circuit. The conceptual circuit diagram is pictured in figure 2. Horizontal drive pulses generated in the monitor are also brought out via an RG 174 coax cable, and drive the transistor TR2 "on" and "off." The amount of power supply voltage TR2 can use depends on the horizontal size control voltage acting on TR4. Since TR2 acts as an on-off switch, the voltage and current swing on the horizontal deflection yoke will be proportional to the horizontal size control voltage. The horizontal deflection yoke, L4, is connected via the choke, L3, to the output of a DC power amplifier for the horizontal position control of the scan, L3 is in the order of 1 millihenry (about 10 times the inductance of the horizontal deflection yoke) and prevents loading of the horizontal ramp signal by the DC power amplifier used for positioning the scan in the X direction. L1, C4, C7 and the horizontal deflection yoke, L4, form a resonant circuit tuned to approximately 50 kilohertz, the fundamental frequency of the horizontal retrace. The tuning is accomplished by selecting capacitor, C4, for maximum deflection without foldover in the horizontal and best linearity. A damper diode, D1, is parallel to the switching transistor, TR2, similar to standard design in television circuitry.

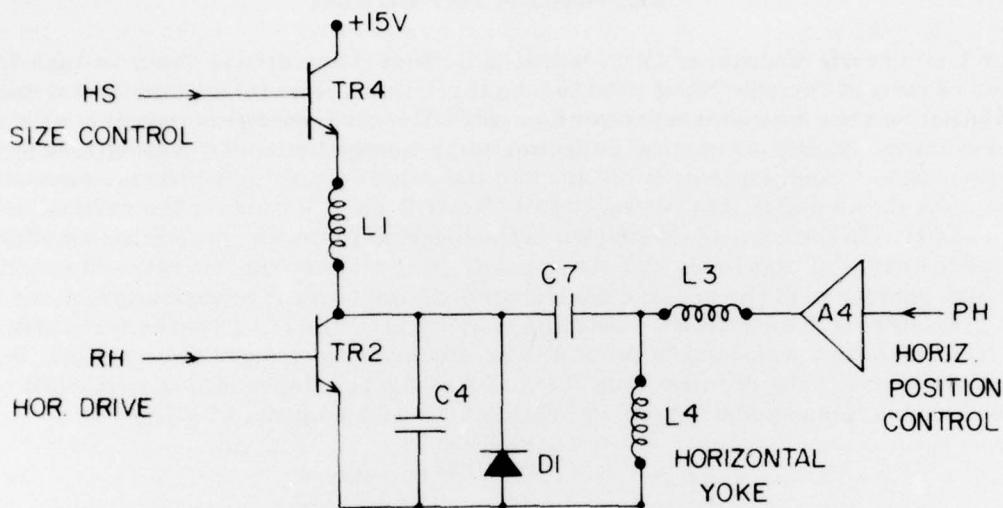


Figure 2. Horizontal Deflection

THE COMPLETE MONITOR DESIGN

The work on the conversion of a commercially available television mointor to a monitor with zoom and picture position control may be divided into two parts: the modification of the monitor, itself, and the design and fabrication of an auxillary electronic unit providing the necessary deflection signals and inputs for the control voltages.

The monitor is modified by disconnecting the deflection yoke from the internal monitor circuitry and bringing the yoke leads via a 6-pin connector out of the monitor and to the auxiliary electronic unit. In addition to the horizontal and vertical drive voltages (generated by the internal monitor circuits) are also brought out via a 4-pin connector. Two inductance coils, one with 167 microhenry for the horizontal and one with 75 millihenry for the vertical, are installed in the monitor itself and connected to the internal circuits instead of the horizontal and vertical deflection yoke. This is necessary to keep the internal deflection circuits working properly and generating the drive and blanking signals, as well as the high voltage (final acceleration voltage of approximately 10 kilovolt) and the focusing voltage. The grid of the cathode ray tube is also brought out via the 6-pole connector to facilitate automatic brightness control with varying image size. Five coaxial cables are used to connect the monitor to the auxiliary deflection unit. The length of this cable should not exceed 3 meters. In one modified monitor we used one meter length of cable. For the horizontal deflection with its higher current, a type-RG 59 coax cable was used while the other four cables are of the RG 174 type. The coaxial cables are used as shield cables with low capacitance, but not in the context of high frequency transmission lines. Careful matching of characteristic cable impedance with load and source impedences is unnecessary, because standing waves causing power loss and reflected signals practically never occur in this application. The maximum frequency of 50 kilocycles represents a wave length of

$$A = \frac{300\,000\,000}{50\,000} = 6000 \text{ meters}$$

compared to a cable length of one meter. Thus, any kind of connector adequate for the currents and voltage may be used, the application of high frequency connectors (BNC) would not be advantageous. There is a limit in cable capacitance for the horizontal deflection signal, as well as a limit in dielectric and resistive losses of the cable. The previously stated maximum length of 3 meters for the cable has been derived from a bench experiment with such a cable. The auxiliary deflection unit is built into an aluminum box measuring 10 by 6 by 3.5 inches. A commercial power supply with ± 15 volts 3 amperes is used outside this box.

CIRCUIT DESCRIPTION

As previously mentioned, two different principles are used for the vertical and the horizontal deflection. The diagram in figure 3 depicts the vertical deflection circuitry. From the deflection circuits in the monitor, a vertical ramp voltage with 1-volt peak-to-peak amplitude is picked up from the emitter of transistor TR 304 (see Panasonic monitor diagram) and capacitively coupled to the operational amplifier A1. The output of this amplifier is 6.5 volts and connected to the Y input of the following integrated circuit multiplier. The X input to this multiplier receives the size control voltage via R15, R16 from the horizontal deflection circuit (0 to +10 volts). The output of the multiplier, a vertical ramp voltage with an amplitude linearly proportional to the size control voltage, is one input to the following operational amplifier A2. The other three inputs to the summing junction of A2 are the vertical positioning voltage (± 10 volts), a voltage derived from a vertical centering control and a current linearization feedback voltage. The final power amplifier, A3, drives (via a coax cable) the vertical deflection yoke of the monitor (terminals E and F in fig. 3).

The approach used for the horizontal deflection is shown in figure 4. Transistor TR1 is driven from a signal picked up in the monitor from the base of transistor TR 402. The horizontal drive transformer, T1, in the collector circuit of TR1 drives switching transistor TR2. Collector current supply for TR2 is controlled by TR4 which, in turn, is controlled by TR3 and finally by the size control voltage (0 to +10 volts) fed to the base of TR3. The base current of TR3 and therefore its collector current is practically a linear function of the size control voltage in the range from +1 to +10 volts. Voltage available to the collector circuit of switching transistor TR2 is also a linear function of the size control voltage, the horizontal deflection current swing, and with it the horizontal length of the scan. Capacitive coupling (C7) of the horizontal deflection yoke is necessary to superimpose a DC current for the scan position control and also for beam centering without a position control voltage. The position control current is supplied from a power amplifier via a one millihenry choke (L3) and a 3-ohm resistor. This position control current is in the range of ± 3 amperes and moves the center of the scan between the left and the right edge of the screen. This current, and with it the positioning range, is basically limited by two factors: the current carrying capability of the horizontal deflection yoke and the current delivery capability of power amplifier A4. In this case, the deflection is limited by the horizontal deflection yoke. The horizontal deflection voltage has a maximum peak-to-peak value of about 120 volts. Diodes D2, D3 and the capacitor C6 generate a DC voltage of a maximum 240 volts used to control the brightness of the image according to the picture size. This brightness control signal is connected by a 1.8 meg ohm resistor to the grid of the cathode ray tube. Capacitor C4 is used to tune the deflection circuit (consisting of L1, C4, C7 and the horizontal deflection yoke) to the fundamental frequency of the retrace ramp. Practically, this tuning is accomplished by experimental selection of C4 for maximum deflection width without horizontal foldover. The value of C4 (0.1 μ F) given in the component list may have to be altered because of the differences in inductance and capacitance by using another monitor. A damper diode (D1) is introduced in a manner similar to conventional deflection circuit design.

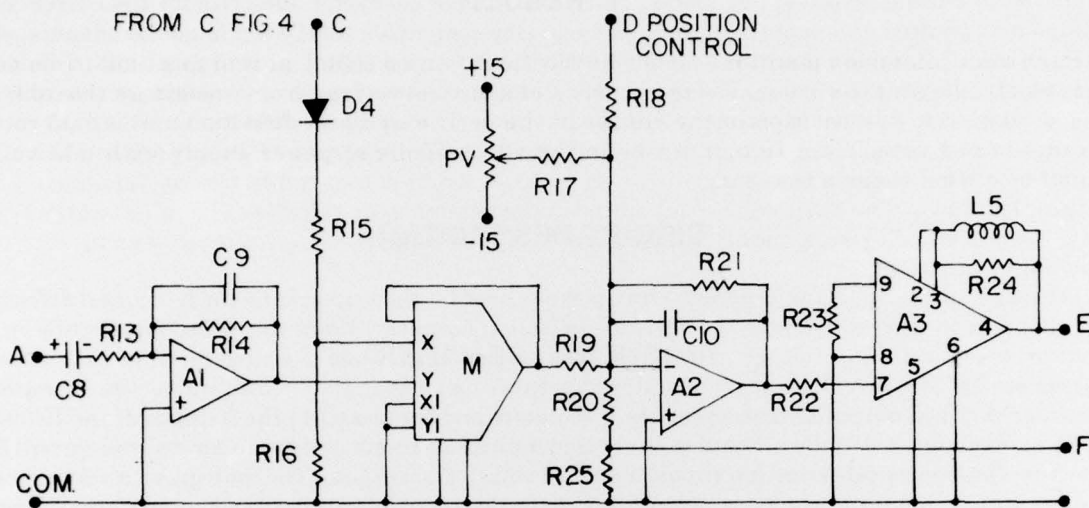


Figure 3. Vertical Deflection Circuit Diagram

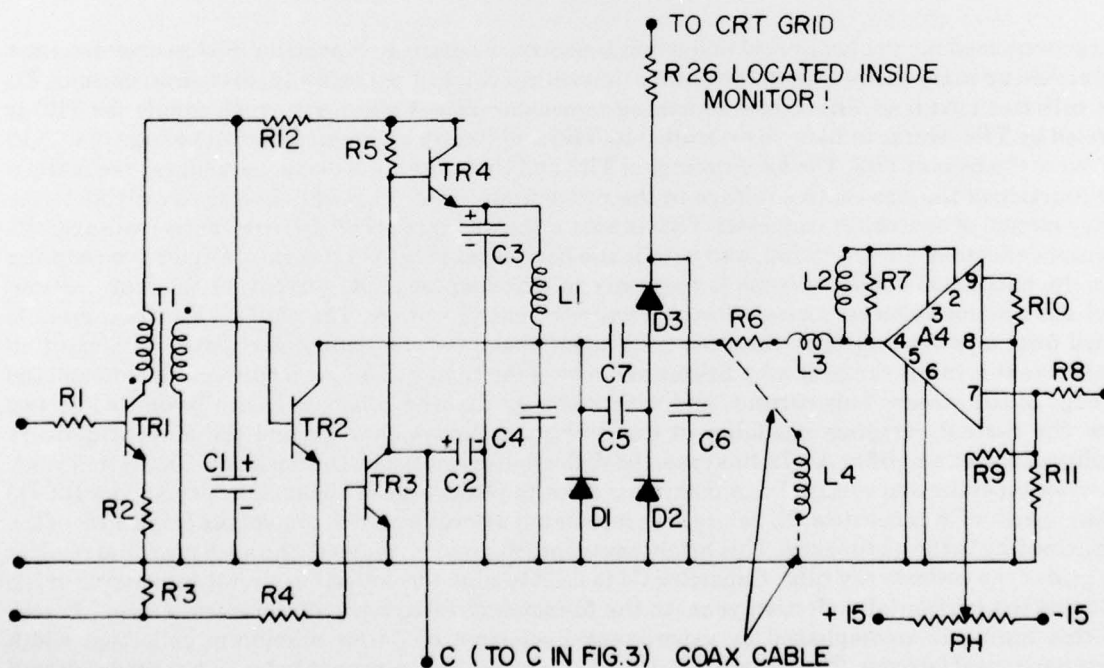


Figure 4. Horizontal Deflection Circuit Diagram

RESULTS

A Panasonic television monitor (model WV950) has been modified and combined with an auxiliary electronic unit to vary scan size by means of a control voltage from full screen size to 1/10 of the screen size. The position of the center of the scan may be shifted by X and Y DC control voltages (± 10 volts) from screen center to the edges of the screen. Resolution, linearity, and stability of the image are not significantly altered when compared to the performance of the original monitor. The basic concept outlined in the report is considered applicable to other types and brands of television monitors, but may require some additional engineering work not outlined in this report.

GENERAL REMARKS

The work outlined in this report was accomplished in response to a requirement from a group of AMRL researchers. The objective was to produce a prototype laboratory model with the specified performance at minimum cost and in the shortest time. This is significantly different from product design in industry. Minimizing material costs in a research laboratory does not translate into absolute minimum cost of all materials, but essentially means to reduce the cost of all materials which have to be procured. Components already in the laboratory (from other projects, design changes, disassembled items, etc.) are much more economical to use than new parts, even though the actual price of the new item is a fraction of the original cost of the component available in the lab. A similar consideration applies to the cost of time. To find a technical approach that could be used with the expenditure of minimum man hours often requires more man hours than the application of an available approach that may be far from optimal in terms of work effort. Well aware of these limitations, the authors still believe that the information in this report could be of value to engineers and technicians in other organizations.

List of Components

Resistors:

| | | | |
|---------|-----------|-----|------------|
| R1, R3 | 22 kohm | R13 | 5.1 kohm |
| R2, R12 | 47 ohm | R14 | 33 kohm |
| R4 | 82 kohm | R15 | 3.3 kohm |
| R6 | 3 ohm 25W | R16 | 2.7 kohm |
| R7 | 22 ohm | R17 | 470 kohm |
| R8 | 5.1 kohm | R18 | 47 kohm |
| R9 | 27 kohm | R19 | 10 kohm |
| R10 | 680 ohm | R20 | 6.8 kohm |
| R11 | 270 ohm | R21 | 33 kohm |
| | | R22 | 2.7 kohm |
| | | R23 | 680 ohm |
| | | R24 | 22 ohm |
| | | R25 | 10 ohm |
| | | R26 | 1.8 megohm |

All resistors are 5%
1/4 watt except for R6

Capacitors:

| | | | |
|----|----------------------------------|-----|-----------------------------------|
| C1 | 25 μ F 25 volt electrolytic | C6 | 0.5 μ F 500 volt |
| C2 | 25 μ F 25 volt electrolytic | C7 | 0.4 μ F 200 volt |
| C3 | 200 μ F 25 volt electrolytic | C8 | 100 μ F, 25 volt electrolytic |
| C4 | 0.1 μ F 200 volt | C9 | 360 pF 100 volt |
| C5 | 0.05 μ F 500 volt | C10 | 560 pF 100 volt |

Potentiometers:

| | |
|------------|----------------------|
| PV, 5 Kohm | VERTICAL CENTERING |
| PH, 5 kohm | HORIZONTAL CENTERING |

Inductances

| | |
|--------|---------------------------------------|
| L1 | 500 microhenry 2A |
| L2 | 1 millihenry (UTC-type VIC-1) |
| L3, L5 | 10 microhenry (Miller 5220) |
| L4 | horizontal deflection yoke in monitor |
| L6 | vertical deflection yoke in monitor |

Amplifiers

| | |
|--------|------------------------------|
| A1, A2 | Dual op. amp Motorola MC1458 |
| A3, A4 | RCA-type HC-2000 (each) |

Transistors

| | |
|-----|-----------------------|
| TR1 | Motorola-type MMP5V45 |
| TR2 | Sylvania-type ECG163 |
| TR3 | 2N3391 |
| TR4 | Motorola-type 2N5069 |

for transistors TR304 and TR402 see original monitor diagram

Miscellaneous Parts

Damper Diode D1 Part No. = YVD 1S689A (Panasonic)
Horizontal drive transformer T1 Part No. = ETH16F6A (Panasonic)
Multiplier M Burr Brown model 4205
Dual power supply ± 15 volt, 3 amperes

